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### INTRODUCTION.

This REVIEW treats generally the meteorological conditions of the United States and Canada for October, 1888, and is based upon reports of regular and voluntary observers of both countries.

On chart i the paths of the centres of eighteen areas of low pressure are shown; the average number traced for October during the last fifteen years being 10.3.

The areas of high and low pressure are discussed under their respective headings. Descriptions of the storms that occurred over the north Atlantic Ocean are also given, and their approximate paths shown on chart i, on which also appear the distribution of icebergs and the limits of fog-belts west of the fortieth meridian.

The severest disturbances on the north Atlantic occurred off the middle Atlantic coast of the United States on the 11th, and over mid-ocean from the 25th to the 28th, when destructive gales attaining hurricane force were reported. There was a deficiency in the aggregate quantity of Arctic ice reported, and fog was less frequently observed than for the preceding month.

A noteworthy feature of the month was the remarkable storm which appeared on the south Pacific coast during the afternoon of the 17th, and moved eastward, reaching the Gulf of Mexico on the morning of the 21st. More rain fell at most of the stations along the route of this storm than had been previously noted during the whole month.

On chart ii the distribution of mean temperature for the month is shown by dotted isotherms. The month was cooler than the average October over a greater part of the country east of the one-hundredth meridian, the deficiencies in mean temperature being most marked from New England southwestward to Tennessee and on the middle Atlantic coast, where they were more than 6°. Over the western part of the country the mean temperature was generally above the normal, the greatest excesses occurring in the Sacramento Valley and over west Montana, where they exceeded 4°. At two stations in Washington Territory the maximum temperatures were the highest reported in October for a series of years.

Chart iii exhibits normal and current October temperature curves for selected stations.

The distribution of rainfall for October, 1888, is shown on chart iv, and the normal precipitation for eighteen years is exhibited on chart v.

In western New England, the Lake region, Florida, south of the thirtieth parallel, and over a greater part of the country west of the Mississippi River the rainfall was deficient, notably in the lower Missouri and Rio Grande valleys, where less than one-half the usual amount for October fell. In the Canadian Maritime Provinces, Maine, the middle Atlantic, south Atlantic, and east Gulf states, over the southern plateau and southern slope of the Rocky Mountains, and along the north Pacific coast it was in excess. Over a considerable part of California there was a total absence of rain. Noteworthy October rainfall data of a more local character are noted under the headings "Excessive Precipitation" and "Floods."

Commencing with July, 1888, the meteorological means for stations of the Signal Service have been determined from observations taken twice daily at 8 a. m. and 8 p. m. (75th meridian time). These hours of observation have been permanently adopted to supersede the former system of tri-daily observations taken at eight-hour intervals.

In the preparation of this REVIEW the following data, received to November 20, 1888, have been used: the regular semi-daily weather-charts, containing data of simultaneous observations taken at 133 Signal Service stations and 22 Canadian stations, as telegraphed to this office; 175 monthly journals and 175 monthly means from the former and 22 monthly means from the latter; 375 monthly registers from voluntary observers; 76 monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the Hydrographic Office, United States Navy, and the "New York Herald Weather Service;" monthly weather reports from the local weather services of Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New England, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, and Texas, and the Central Pacific Railway Company; trustworthy newspaper extracts, and special reports.

### ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure for October, 1888, as determined from observations taken daily at 8 a. m. and 8 p. m. (75th meridian time), is shown on chart ii by isobars. On July 1, 1888, the tri-daily observations of the Signal Service were superseded by observations taken twice daily at the hours named. A protracted series of hourly observations has shown that the difference is almost inappreciable between the mean pressure obtained from two observations taken at these hours and that determined from tri-daily observations taken at eight-hour intervals.

The mean pressure for October, 1888, was highest over the south Atlantic states and western Oregon, where it rose to 30.08. The area of lowest mean pressure occupied the lower Colorado valley, where the values fell to 29.81 at Yuma, Ariz. In the lower Saint Lawrence valley and along the west coast of the Gulf of Saint Lawrence the mean readings were below 29.85, while in the Saskatchewan Valley they fell below 29.90.

As compared with the pressure chart for September, 1888, an increase is shown over the south Atlantic states south of the thirty-fifth parallel, and from thence westward to the ninety-

seventh meridian; along the Pacific coast south of the forty-seventh parallel, and over a greater part of the plateau region of the Rocky Mountains. The greatest increase has occurred over northern California and southern Florida, where it amounts to .10 and .07, respectively. From the Rio Grande Valley northward to the British Possessions, and over the entire eastern part of the country north of the thirty-fifth parallel, there has been a decrease in pressure, which becomes more marked eastward to the Canadian Maritime Provinces, where it amounts to .21.

As compared with the normal pressure for October, the mean barometer readings for the current month were below the normal, except over southern Florida and northern Nevada, where the departures above the normal were less than .03. The departures below the normal were most marked over Nova Scotia and New Brunswick, where they exceeded .20. From this locality southwestward to the Gulf of Mexico and westward to the middle plateau region of the Rocky Mountains the deficiencies become less marked; in California and Arizona they varied from .05 to .09, while over Oregon and Washington Territory they were less than .05.

#### BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Service stations are given in the table of miscellaneous meteorological data. The ranges conform to the general rule, that is they increase with the latitude and decrease slightly, though somewhat irregularly, with increasing longitude. Along the Atlantic coast the extreme ranges varied from .42 at Key West, Fla., to 1.43 at Eastport, Me.; between the eighty-second and ninety-second meridians, .50 at New Orleans, La., to 1.04 at Alpena, Mich.; between the Mississippi River and Rocky Mountains, .38 at Brownsville, Tex., to 1.03 at Poplar River, Mont.; in the plateau and Rocky Mountain regions, .38 at Fort Grant, Ariz., to .92 at Spokane Falls, Wash.; on the Pacific coast, .28 at Los Angeles and San Diego, Cal., to .74 at Olympia, Wash.

#### AREAS OF HIGH PRESSURE.

During October there were ten well-defined areas, five of which were first noted on the Pacific coast, three in Manitoba, and one in Arkansas. The general direction was east-southeast, and i, v, vi, vii, and ix passed off the southeast Atlantic coast and were merged in the permanent area of high pressure in the Saragossa Sea, that area having apparently moved slightly westward. This rather persistent trend of the high areas combined with the persistency of the low areas to the northeast accounts for the abnormal conditions over New England and the Atlantic coast. Only two areas, iii and viii, passed off to the northeast, and the remainder died out before reaching the Atlantic.

The following table exhibits, in a concise manner, some of the more prominent characteristics of the high areas:

No.	First observed.			Last observed.			Duration.	Velocity per h.r.	Highest pressure.		
	Date.	Lat. N.	Long. W.	Lat. N.	Long. W.				Date.	Station.	Reading.
I.....	1	52	108	35	73	3-5	28		2	Saint Vincent, Minn....	30.36
II.....	4	53	101	32	96	3-5	15		6	North Platte, Nebr....	30.32
III.....	7	51	91	51	63	5-0	18		9	Green Bay, Wis.....	30.16
IV.....	8	42	126	50	97	4-5	22		12	Rapid City, Dak.....	30.28
V.....	13	35	92	33	76	2-0	20		14	Mobile, Ala.....	30.18
VI.....	13	46	124	31	76	6-0	23		18	Lynchburg, Va.....	30.38
VII.....	17	47	123	33	73	5-5	26		19	Cheyenne, Wyo.....	30.46
VIII.....	20	47	124	42	62	4-5	33		22	Roseburg, Oregon.....	30.46
IX.....	26	47	120	33	70	5-0	29		31	Norfolk, Va.....	30.46
X.....	30	47	122	52	95	1-5	40		31	Minneapolis, N. W. T....	30.14
							25.4			Mean.....	30.32

It is interesting to note that during October the mean of the several highest readings is 30.32, while in September the same mean was 30.46. The highest pressure during the month was 30.46, which is remarkably low for this month. In general

most of the high areas were not as well-defined as usual for October. The mean velocity is slightly greater than in September. It should be noted that this velocity is often difficult to ascertain owing to an indefiniteness in the movement. This velocity is determined from the forward motion of the high area for each twelve hours, and it does not indicate the eastward velocity of the upper current in which the high area may be supposed to move, which must be much greater.

I.—This area was first noted on the morning of the 1st to the north of Montana. It moved rapidly to the southeast and passed off the south Atlantic coast on the 4th. Killing frosts occurred during its progress in the Ohio Valley morning of the 3d, and in Virginia morning of the 4th. During the progress of this and all other high areas the diurnal range of air pressure was very marked, ranging from .10 to .15 each twenty-four hours in the portions where the sky remained clear. During the passage of low areas this phenomenon was not noted, which was to be expected, owing to the cloudiness of the sky. It is suggested that this may lead to an additional method of investigating this peculiar phenomenon, which has never yet been satisfactorily explained.

II.—This area appeared in Manitoba on the 4th. It moved nearly due south to Texas, where it gradually died out on the 9th. It had the least rate of progress of any of the areas of the month.

III.—First noted to the north of Michigan; it moved southeast to Ohio, where it turned at right angles and moved up the Saint Lawrence Valley, disappearing on the 12th.

IV.—Appearing on the north Pacific coast on the 8th, it moved nearly east, and was lost sight of in Manitoba on the 13th.

V.—This area was an off-shoot of the last, first noted in Arkansas afternoon of the 13th. It moved due east, and passed off the Atlantic coast two days later.

VI.—This area was first noted off the north Pacific coast the afternoon of the 13th. Its track was a little south of east, passing off the south Atlantic coast the afternoon of the 18th.

VII.—This area, like the last, first appeared off the north Pacific coast. From the 17th to the 21st it moved nearly due east along the forty-fifth parallel to Lake Huron; it then turned abruptly nearly south, and on the next day passed off the middle Atlantic coast. The greatest falls in temperature for twenty-four hours occurred during the progress of this area, 30° at Cheyenne morning of the 19th, 30° at Fort Smith morning of the 20th, and 24° at Lynchburg afternoon of the 20th.

VIII.—This, like the last two, first appeared on the north Pacific coast. In three days it moved southeast to Texas, then turning east-northeast it moved off the coast of Nova Scotia on the 26th. Its motion, thirty-three miles per hour, was exceeded only by x.

IX.—First noted on the 26th in Washington Territory. This area moved southeast to Alabama, then nearly east, passing off the middle Atlantic coast on the 30th.

X.—This area was first noted in Washington Territory on the 30th, and moved very rapidly (forty miles per hour) due east, being in Manitoba on the last day of the month.

#### AREAS OF LOW PRESSURE.

There were eighteen areas of low pressure sufficiently marked, within the area of observation, to be traced. The general trend of these will be found on chart i, accompanying this REVIEW; iv, xi, xiv, xvi, and xviii were too far north to have the velocity determined.

Their velocity seemed to have a maximum about the 3d, a minimum near the 13th, and another maximum on the 21st. The average velocity was 25.4 miles per hour, which was exactly the same as that of the high areas. All storms traced for more than one day east of the ninety-second meridian moved toward the northeast or east, and these paths converged over the Saint Lawrence Valley. As previously noted the persistency of the high areas to the east of the south Atlantic states,

together with an apparent westward movement of the permanent area of low pressure in Smith's Sound, dominated the weather in the New England and middle Atlantic states.

The following table exhibits the principal facts regarding these low areas. The heading of each column shows to what the figures refer:

No.	First observed.			Last observed.			Duration.	Velocity per h'r.	Lowest pressure.		
	Date.	Lat. N.	Long. W.	Lat. N.	Long. W.				Date.	Station.	Reading.
I.....	1	44	84	50	64	Days.	Miles.		3	Chattanooga, Tenn.....	29.28
II.....	2	50	112	47	71	3.0	24		3	Winnipeg, Manitoba....	29.60
III.....	3	36	104	49	66	2.5	32		8	Chatham, N. B.....	28.90
IV.....	7	52	112	53	95	6.5	22		11	Medicine Hat, N. W. T.	29.54
V.....	10	39	84	42	70	2.0	21		12	Charleston, S. C.....	29.36
VI.....	12	49	123	47	60	7.0	22		18	Bird Rocks, G. of St. L.	29.32
VII.....	12	41	84	42	69	2.0	17		12	Toledo, Ohio.....	29.60
VIII.....	13	41	105	38	92	1.5	31		13	Denver, Colo.....	29.78
IX.....	17	42	114	48	66	4.0	28		19	Marquette, Mich.....	29.52
X.....	17	49	114	48	87	2.0	28		18	Minnedosa, N. W. T.....	29.68
XI.....	19	50	127	53	107	1.5	19		19	Calgary, N. W. T.....	29.70
XII.....	20	35	108	45	62	2.5	31		24	Sydney, C. B. I.....	29.62
XIII.....	23	50	117	50	92	2.0	23		23	Calgary, N. W. T.....	29.26
XIV.....	24	28	89	32	87	2.0	25		25	Port Eads, La.....	29.84
XV.....	25	37	102	48	63	4.5	24		29	Chatham, N. B.....	28.86
XVI.....	27	51	125	54	108	1.0	27		27	Edmonton, N. W. T.....	29.67
XVII.....	28	48	113	50	72	3.0	27		30	Minnedosa, N. W. T.....	29.52
XVIII.....	31	42	113	43	109	0.5	31		31	Salt Lake City, Utah....	29.66
							25.4			Mean.....	29.41

The following is a description of some of the characteristics of these low areas:

I.—This was the continuation of ix of the last month noted over Lake Superior on the 30th. Its motion was nearly due east passing to the Saint Lawrence Valley on the 4th. Destructive storms occurred in Ohio and Georgia to the south and southeast of this storm on the 2d. The wind reached sixty miles per hour at Montreal on the morning of the 4th. As often noted before the precipitation in this and nearly all storms of the month was exceedingly irregular. For example; .15 inch at Sandusky; .03 at Parkersburg; .12 at Block Island; 1.64 at Erie; 1.50 at Buffalo, and 1.30 at Albany. It has generally been supposed that heavy local precipitation occurred almost exclusively in connection with thunder and other violent local storms in the summer, but here we have the same effect when there were no local storms. It would seem as though, after the pressure, the precipitation must give us a better idea of the forces acting at the seat of the storm and a study of its distribution and occurrence cannot fail to shed light upon many intricate problems.

II.—This low area was first noted on the 1st just north of Montana; its path just crossed within the boundary of Dakota on the 3d, and its last position was, on the 5th, in the upper Saint Lawrence valley.

III.—First noted in New Mexico on the 3d; its track was nearly northeast, disappearing in the upper Saint Lawrence valley on the 10th. In connection with this storm occurred the waterspout on the 7th, as noted elsewhere. In this storm .10 inch rain fell at Davenport, .26 at Block Island, .43 at Rochester, 2.96 at Kansas City, 1.98 at Fort Smith, 1.88 at New York City, 1.86 at Albany, 1.20 at Boston, 2.18 at Portland, and 3.26 at Eastport; these later-named comprise all the stations at which more than one inch fell.

IV.—This low area originated to the north of Montana on the 7th. Its path was entirely to the north of the boundary, and was last noted in Manitoba on the 10th.

V.—This storm was first noted on the 10th in the eastern Gulf;

its motion was northeast, and it was last definitely located, by land observations, off the Massachusetts coast on the 13th.

VI.—This storm was first noted off the north Pacific coast on the 11th. Its motion was nearly due east, being last noted near Newfoundland on the 19th. The heaviest rainfalls during its progress were .72 at Cairo, .66 at Buffalo, and .84 at Parkersburg.

VII.—This storm was first observed in Ohio on the 12th. It slowly moved eastward, being last observed on the 14th off the Massachusetts coast. On the 14th a waterspout occurred to the southeast of the low centre.

VIII.—First noted in Colorado on the 13th; this disturbance moved rapidly in a path curving slightly to the southward, and gradually filled up on the 15th in Missouri.

IX.—This storm apparently had its origin near northern Nevada on the 17th. Its motion was a little north of east, and it was last noted in the upper Saint Lawrence valley on the 21st. During this storm .18 inch rain fell at Des Moines, .36 at Milwaukee and Keokuk, while 2.10 fell at Davenport, 1.92 at Indianapolis, and only .14 at Louisville. Severe local storms occurred in connection with this storm on the 19th in Maryland and New York.

X.—This disturbance first appeared north of Montana on the 17th. Its motion was a little south of east, and it was merged in ix over Lake Superior on the 19th.

XI.—This was first noted off the north Pacific coast on the 19th. Its motion was to the eastward, and it was last noted in Manitoba on the 20th, its path having been above the boundary.

XII.—In many respects this was the most interesting storm of the month. For several days previous to the 20th there were experienced unusual clouded skies and rainfall in southern California and western Arizona. While the rainfall on the immediate south Pacific coast was slight, .32 at Los Angeles and .25 at San Diego, yet the heaviest fall in October since the beginning of observations was noted at interior stations, 1.75 at Prescott, 1.09 at Yuma, 1.56 at Stanton, &c. At many of the stations the single fall in this storm exceeded all previous total falls for October. The disturbance reached Texas on the 22d; 3.92 rain fell at Galveston. The rainfall at New Orleans was also very heavy in the twelve hours ending the afternoon of the 22d, 3.74 fell, while only .33 fell at Port Eads. While a portion of this storm moved to the northeast, disappearing near Newfoundland on the 25th, a disturbance, an off-shoot, still remained in the western Gulf, which was xiv, as described below.

XIII.—This low area was first noted to the north of Idaho on the 23d. Its path was nearly due east, it gradually dying out near Lake Superior on the 25th.

XIV.—This disturbance was a portion of xii, which remained in the Gulf. Its path was traced a very short distance, as it gradually died out in Alabama on the 26th. It is probable that the water-spout of the 25th was a secondary effect of this storm.

XV.—On the 25th this disturbance appeared to develop gradually in Kansas. The motion was northeastward, and it disappeared near Newfoundland on the 29th. The lowest pressure of the month, 28.86, occurred at Chatham during the progress of this storm on the 29th.

XVI.—This disturbance was noted to the north of Washington Territory on the 27th. Its path was above the boundary, and it was last noted on the 28th in Manitoba.

XVII.—This storm was first seen in Montana on the 28th. Its path was due east, and on the last day of the month it had reached the Province of Quebec.

XVIII.—This storm originated in Idaho on the 31st, and was traced to Wyoming on the afternoon of the same day.

#### NORTH ATLANTIC STORMS FOR OCTOBER, 1888 (pressure in inches and millimetres; wind-force by Beaufort scale).

The paths of the depressions that appeared over the north Atlantic Ocean during October, 1888, are shown on chart i. These paths have been determined from international simultaneous observations by captains of ocean steamships and

sailing vessels, received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Eleven depressions have been traced, of which six advanced